MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2017/2018

DET5068 – ANALOG ELECTRONICS 1

(Diploma in Electronic Engineering)

14 OCTOBER 2017
2:30 PM – 4:30 PM
(2 HOURS)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **12** pages (**6** pages with **4** questions and **6** pages for appendix).

2. Answer **ALL** questions. All necessary working steps must be shown.

3. Write all your answers in the answer booklet provided.

QUESTION 1 [25 Marks]

a)

A trivalent atom with atomic number, A of 5 is to be added into an intrinsic silicon, (Si) which has atomic number of 14 to increase a certain conductivity carrier and make it useful in electronic devices.

(i) Name and explain the process in the statement above.

[3 marks]

(ii) Determine the atomic configuration for both trivalent and silicon atoms.

[2 marks]

(iii) Describe the process in the statement above in detail.

[6 marks]

b)

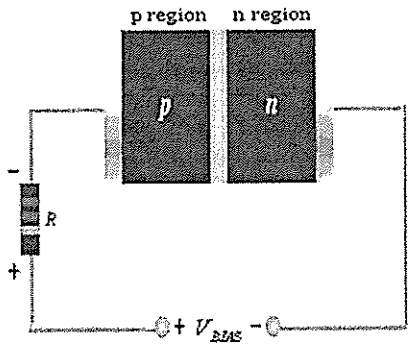

Figure 1

Figure 1 shows the bias condition of a silicon p-n junction diode. Answer the following:

(i) State the bias condition of the p-n junction.

[1 mark]

(ii) Draw the V-I characteristics curve for the above circuit connection.

[3 marks]

(iii) Explain in details about its basic operation.

[5 marks]

(iv) Explain the behavior of the depletion region in this bias condition.

[1 mark]

c) Define the following terms:

(i) Rectifier

[2 marks]

(ii) Filter

[2 marks]

Continued...

QUESTION 2 [25 Marks]

a) Figure 2(a) and Figure 2(b) below show two types of diode applications respectively.

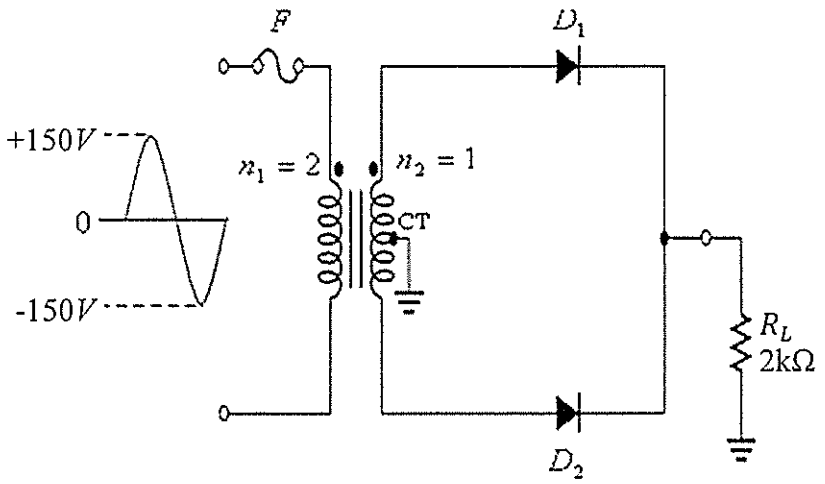

Figure 2(a)

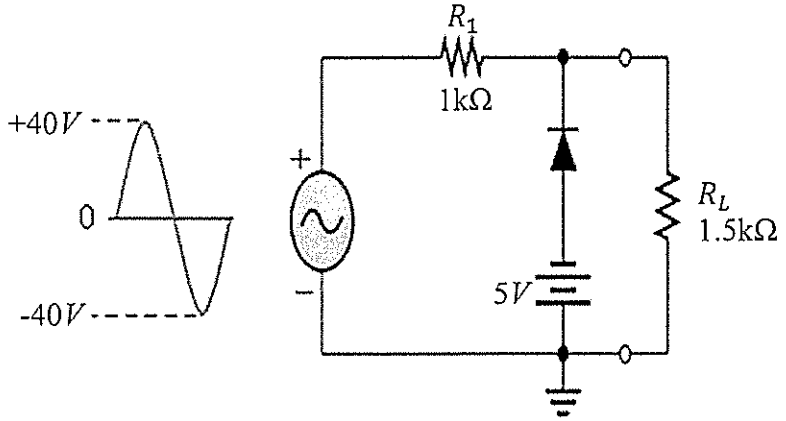

Figure 2(b)

Calculate and **sketch** the output voltage, $V_{p(out)}$ across R_L for each of the applications above.

[11 marks]

Continued...

b) A special purpose diode has the following specifications:

Zener test voltage, $V_{ZT} = 10V$

Zener impedance, $Z_Z = 9\Omega$

Zener test current, $I_{ZT} = 45mA$

Zener knee current, $I_{ZK} = 5mA$

Zener maximum current, $I_{ZM} = 85mA$

Determine the terminal voltage, V_Z when the terminal current, I_Z is given as follows:

(i) $60mA$

[6 marks]

(ii) $2mA$

[2 marks]

c) Define electroluminescence.

[2 marks]

d) State **FOUR** types of special-purpose diode and sketch their symbol respectively.

[4 marks]

Continued...

QUESTION 3 [25 Marks]

a) Sketch a transistor circuit that has the following specification: $R_B = 100k\Omega$, $R_C = 1.2k\Omega$, $V_{BB} = 5V$, $V_{CC} = 15V$ and $\beta_{DC} = 100$. Label the entire component's notation and determine I_B, I_C, I_E, V_{CE}, V_{BE} and V_{CB}.

[15 marks]

b) Figure 3 shows a certain BJT bias method. **Name** the biasing method and determine its **Q-point** if DC beta, $\beta_{DC} = 150$. The transistor is made of silicon.

[10 marks]

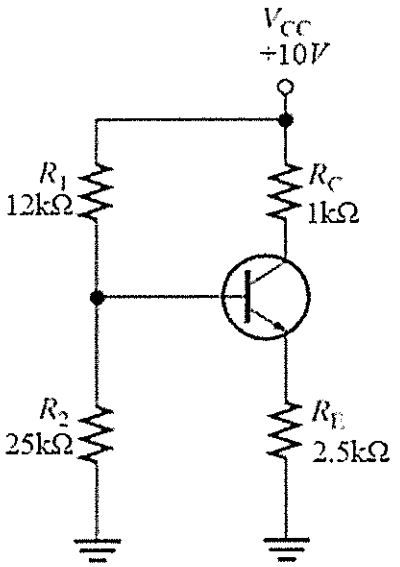

Figure 3

Continued...

QUESTION 4 [25 Marks]

a) Briefly describe the meaning of:

(i) DC operating point

[1 mark]

(ii) DC load line

[1 mark]

(iii) Amplifier

[1 mark]

b) Figure 4 shows a certain BJT bias method. If the transistor is made from silicon, name the bias method and determine the **Q-point**.

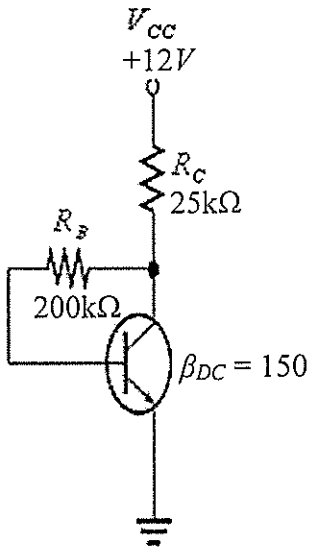

Figure 4

[7 marks]

Continued...

c) Figure 5 indicates a certain type of BJT amplifier. Given that $\beta_{ac} = 100$ and $V_{in} = 2mV_{rms}$, answer the following questions:

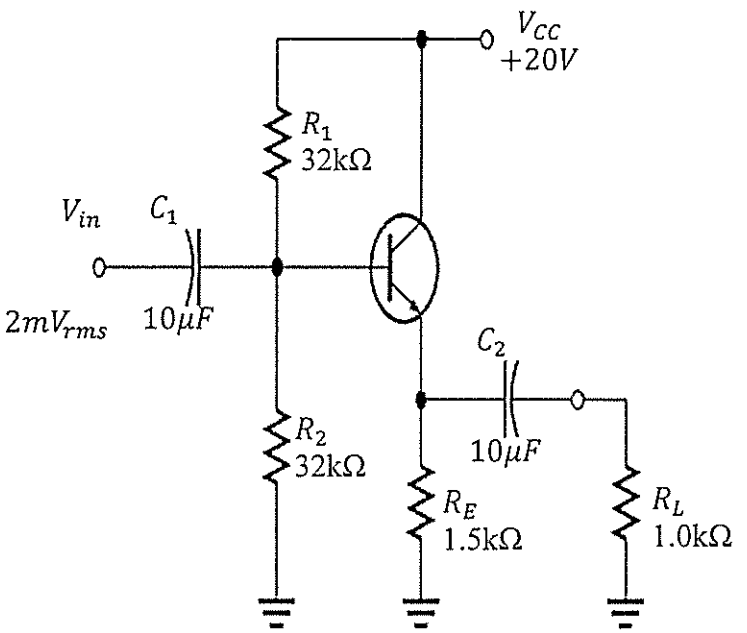

Figure 5

(i) **Identify** the type of the BJT amplifier in Figure 5.

[1 mark]

(ii) **Calculate** the value of ac total input resistance, $R_{in(tot)}$

[6 marks]

(iii) **Calculate** the value of ac current gain, A_i

[8 marks]

End of Page.

FORMULAE LIST

BJT BIAS	
TERMS	**FORMULAE**
DC load line equation	$I_C = -\frac{1}{R_C}V_{CE} + \frac{V_{CC}}{R_C}$
Voltage divider-bias:	
DC collector and emitter current	$I_C \cong I_E = \frac{V_E}{R_E}$
DC base voltage	$V_B = \frac{R_2 \,//\, R_{IN(BASE)}}{R_1 + \left(R_2 \,//\, R_{IN(BASE)}\right)} \times V_{CC}$ $V_B = \frac{R_2}{R_1 + R_2} \times V_{CC}$ if, $R_{IN(BASE)} >> R_2$
DC collector voltage	$V_C = V_{CC} - I_C R_C$
DC collector-to-emitter voltage	$V_{CE} = V_{CC} - I_C\left(R_C + R_E\right)$
DC emitter voltage	$V_E = V_B - V_{BE}$
DC input resistance at the base	$R_{IN(BASE)} = \beta_{DC} R_E$
DC total resistance	$R_T = R_2 \,//\, \beta_{DC} R_E$
Base bias:	
DC base current	$I_B = \frac{V_{CC} - V_{BE}}{R_B}$

DC collector current	$I_C = \frac{\beta_{DC}(V_{CC} - V_{BE})}{R_B}$
DC collector-to-emitter voltage	$V_{CE} = V_{CC} - I_C R_C$
Collector-feedback bias:	
DC base current	$I_B = \frac{V_C - V_{BE}}{R_B}$
DC collector current	$I_C = \frac{V_{CC} - V_{BE}}{\frac{R_B}{\beta_{DC}} + R_C}$
DC collector-to-emitter voltage	$V_{CE} = V_{CC} - I_C R_C$
Emitter bias:	
DC base current	$I_B \cong \frac{I_E}{\beta_{DC}}$
DC collector current	$I_C \cong \frac{-V_{EE} - V_{BE}}{\frac{R_B}{\beta_{DC}} + R_E}$
DC emitter current	$I_E = \frac{-V_{EE} - V_{BE}}{\frac{R_B}{\beta_{DC}} + R_E}$
DC base voltage	$V_B = V_E + V_{BE}$
DC collector voltage	$V_C = V_{CC} - I_C R_C$
DC collector-to-emitter voltage	$V_{CE} = V_C - V_E$

DC emitter voltage	$V_E = V_{EE} + I_E R_E$
BJT AMPLIFIERS	
TERMS	**FORMULAE**
***r* Parameters:**	
ac base resistance	$r_b^{'} = h_{ie} - \frac{h_{re}(h_{fe}+1)}{h_{oe}}$
ac collector resistance	$r_c^{'} = \frac{h_{re}+1}{h_{oe}}$
ac emitter resistance	$r_e^{'} = \frac{h_{re}}{h_{oe}}$
Common-base amplifier:	
DC emitter current	$I_E = \frac{V_E}{R_E}$
DC base voltage	$V_B = \frac{R_2}{R_1 + R_2} \times V_{CC}$
DC emitter voltage	$V_E = V_B - V_{BE}$
ac output voltage	$V_{out} = V_c$
ac input voltage	$V_{in} = V_e$
ac resistance at emitter	$R_{in(emitter)} \cong r_e^{'}$
ac output resistance	$R_{out} \cong R_C$

Current gain	$A_i \cong 1$
Voltage gain	$A_v \cong \frac{R_c}{r_e'}$
Power gain	$A_p = A_v$
Common-collector amplifier:	
ac input current	$I_{in} = \frac{V_{in}}{R_{in(tot)}}$
ac emitter current	$I_e = \frac{V_e}{R_e}$
ac emitter voltage	$V_e = A_v V_b$
ac input resistance at base	$R_{in(base)} \cong \beta_{ac} R_e$
ac total input resistance	$R_{in(tot)} = R_1 // R_2 // R_{in(base)}$
ac output resistance	$R_{out} \cong \left(\frac{R_s}{\beta_{ac}}\right) // R_E$
Current gain	$A_i = \frac{I_e}{I_{in}}$
Voltage gain	$A_v \cong 1$
Power gain	$A_p = A_i$

Common-emitter amplifier:	
DC collector current	$I_C \cong I_E$
DC base voltage	$V_B = \frac{R_2}{R_1 + R_2} \times V_{CC}$
DC collector voltage	$V_C = V_{CC} - I_C R_C$
DC collector-to-emitter voltage	$V_{CE} = V_C - V_E$
DC emitter current	$I_E = \frac{V_E}{R_E}$
DC emitter voltage	$V_E = V_B - V_{BE}$
DC input resistance at base	$R_{IN(BASE)} = \beta_{DC} R_E$
ac base current	$I_b \cong \frac{I_e}{\beta_{ac}}$
ac base voltage	$V_b = \frac{R_{in(tot)}}{R_s + R_{in(tot)}} \times V_s$ $= I_e r_e'$
ac collector voltage	$V_c = A_v' V_x$
ac total current signal	$I_s = \frac{V_s}{R_{in(tot)} + R_s}$

ac input resistance at base	$R_{in(base)} = \beta_{ac} r'_e$
ac total input resistance	$R_{in(tot)} = R_1 // R_2 // R_{in(base)}$
ac output resistance	$R_{out} \cong R_C$
Current gain	$A_i = \frac{I_c}{I_s}$
Voltage gain	$A_v = \frac{R_C}{r'_e}$ if C_2 exists $A_v = \frac{R_C}{r'_e + R_E}$ if C_2 does not exist
Overall voltage gain	$A'_v = Attenuation \times A_v$
Power gain	$A_p = A'_v A_i$